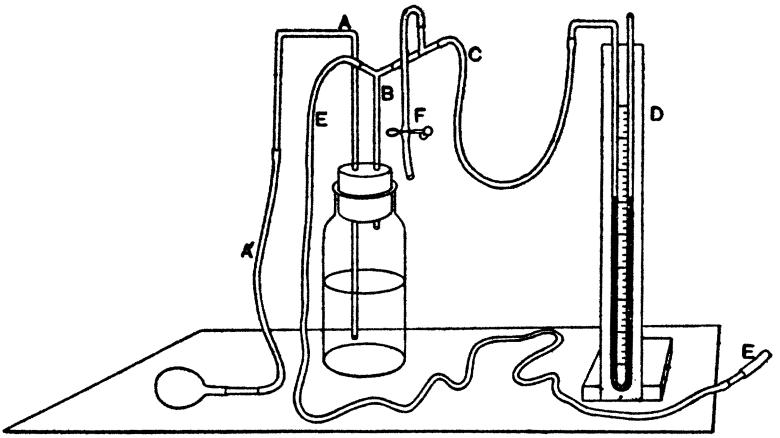
ON THE PRESSURE SENSE OF THE DRUM OF THE EAR AND "FACIAL-VISION."

By F. B. Dresslar.

The purpose of this investigation was to determine in what way one is able to know when he is in the presence of objects even beyond his reach when the eyes are shut and blindfolded. This ability is especially strong with the blind, and sometimes spoken of by them as "facial vision." They not only receive much help thus in the way of protection, as is well known, but they are led to a more certain and definite knowledge of their environment than those who see are wont to think. A friend of the writer, blind from birth, could not only tell, for example, when he was approaching a forest and something of its general character, but he derived in some way much of the æsthetic feelings those who see get from sight alone. His horizon was by no means the indefinite blank homogeneity most often attributed to the blind, but it presented to him a variety approaching in a degree that of his more fortunate fellows. Much of this knowledge was due to association and inference, but much of it was gained through direct sense perception. Since the blind have no new sense, but impose on those remaining a greater task, it seemed important to determine in what degree of efficiency this capacity exists in those who see, and to analyze this sensation of "shut-in-ness" as far as possible. Prof. James says:[1] "The tympanic membrane is able to render sensible differences in pressure of the external atmosphere too slight to be felt as noise," and in a foot note says: "That the sensation in question is one of tactile rather than of acoustic sensibility would seem proved by the fact that a medical friend of the writer, both of whose *membranæ tympani* are quite normal, but one of whose ears is almost totally deaf, feels the presence and withdrawal of objects as well at one ear as at the other." In order to test this theory, a large number of experiments were made with a piece of apparatus, of which the following is a description:

[1] Psychology, Vol. II, p. 140.



Apparatus for Applying and Determining the Least Observable Amount of Atmospheric Pressure on the Tympanum of the Ear. A wide-mouthed bottle was corked with a rubber cork, which was pierced with two holes. In these holes two glass tubes were fitted, so that one (A) reached near the bottom of the bottle within, while the other (B) was much shorter. Tube (B) ended without in a double Y. Each of these openings and also the one at (A') was fitted with a rubber tube. Tube (A') ended in a bulb. (C) was connected with a manometer, which was fastened to an upright standard (D) and partially filled with ink. Behind this glass tube a milimeter scale was so adjusted that an observer could note the amount of the rise and fall of the liquid in the tube.

A long tube at (E) ended in a soft nozzle prepared to fit easily but closely into the external meatus of the ear. The one at (F) could be opened and closed at will to relieve any pressure caused by adjusting the tube (E) in the ear. In order, then, to determine the least perceptible amount of pressure, it was only necessary for the subject to adjust the tube in his ear, and, after the operator had restored the equilibrium, to indicate by a signal when he felt the pressure which was applied by the operator on the bulb. The height to which the column of ink was raised thus measured the pressure exerted. After each trial the subject removed the tube from his ear for a short time, then the process was repeated for ten trials.

The following table shows the averages and average variations of pressure, with F. B. D. as a subject, for a series of seven observations, each series consisting of ten trials for each

ear. These were taken irregularly for a period of a month or more:[1]

Right Ear.				Left Ear.			
No.	Height of Column in mm.	Av. Variation in mm.	Amount of Pressure in grams.	No.	Height of Column in mm.	Av. Variation in mm.	Amount of Pressure in grams.
1	33.	3.9	.32	1	50.4	1.66	.47
2	44.6	3.4	.43	2	57.2	2.	.54
3	32.8	1.84	.31	3	40.8	1.8	.38
4	38.6	1.48	.36	4	42.2	.94	.40
5	38.2	1.6	.35	5	41.	1.	.39
6	36.	2.4	.34	6	36.2	2.24	.34
7	41.8	1.44	.39	7	30.	.6	.29

Conclusions from the Above Experiments: 1. That it is a mistake to ascribe to the tympanum a very great delicacy in the perception of pressure. 2. That the sensation of being "shut in" is not due to tympanic pressure, because it is not possible for so much pressure to be exerted on the tympanum by merely approaching an object.

Suggestions: 1. The method used suggested a much better plan for determining the threshold for minimal pressure than heretofore used. It was noticed that the height to which the pressure could be raised before being felt depended on the suddenness and rapidity with which the pressure was applied. By using a regulated mechanical pressure, the variations in the threshold for pressure as affected by rate could be more clearly determined. 2. The bilateral asymmetry noticed in the above records suggests additional evidence in functional asymmetry of the two sides of the body.

Having seen that tympanic pressure could be wholly excluded as an element in the sensation, the next thing was to find a method by which the relative value of the three remaining possible elements, viz., temperature, sound and "facial vision," could be determined. This was accomplished with the following apparatus:

Apparatus and Method for Determining the Effect of Temperature, Sound and "Facial Vision." A light frame-work of wood was made four feet long and one foot wide, and divided into four spaces, each one foot square. The first one of these spaces was left open, the second latticed with strips

[1] It should be said that practically the same results as the above were obtained in the same way with two other subjects, but unfortunately the figures were lost.

three-quarters of an inch wide, and with spaces of one-half of an inch between them; the first space was closed solidly with a panel of wood, while the fourth was filled with a wire screen. The frame was then suspended from a high ceiling by four strings, fastened in pairs as guys (so that it would swing lengthwise easily and without swerving), and made to swing low enough to be opposite the face of the subject. A silk thread was fastened to the ends of the frame, and passed over small pulleys inserted in standards set some ten feet from each end of the frame. The two ends of the strings were then tied together to furnish the operator an easy and noiseless method for shifting the frame to bring the different spaces opposite the ear and face of the subject.

The method of work was as follows: The subject with closed eyes was blindfolded in such a way that little or none of the face but the eyes was covered; he was seated comfortably with his face at a distance of two or three inches from the path of the frame, and asked to judge between two spaces irregularly presented. He was required to indicate his judgment by a prearranged system of signs in order to prevent any reverberation of the voice which might vitiate the results. The first set of judgments were thus taken, and were for the purpose of finding the degree of power to distinguish between the three following pairs: Open—lattice; lattice—solid; solid—wire. The accompanying table shows the discriminative ability thus drawn out for different subjects:

Subject.	Open and Lattice.				Lattice and Solid.				Solid and Wire.			
	R.	W.	R.	W.	R.	W.	R.	W.	R.	W.	R.	W.
J. A. B.	65	15	59	25	58	2	56	0	45	0	46	2
O. C.	72	47	74	46	33	13	28	14	21	4	14	9
F. B. D.	53	24	58	17	69	1	70	4	73	0	77	2

Explanation of Table.—The figures in the columns marked *R* indicate the number of correct judgments, those in columns marked *W* incorrect. For example, when J. A. B. judged between the open and lattice spaces, he made 65 right and 15 wrong judgments in 80 presentations of the open, and 59 right and 25 wrong in 84 presentations of the lattice; while judging between lattice and solid, he made 58 right and 2 wrong judgments in 60 presentations of the lattice, and 56 right and no wrong judgments when the solid was presented, and so on for all the others.

After each set of experiments, the subjects were asked to state as nearly as possible just what they thought they had

used as a basis for discrimination. This was done for the double purpose of gaining therefrom hints as to method, and also as to the accuracy of introspection and the ability to analyze these sensations. The following answers cover the main points made:

J. A. B.—1. I could not hear the movements of the apparatus. 2. Reflected sounds formed the chief basis of judgment. Footsteps outside have different qualities of sound when the different parts are opposite the face. 3. There is a sort of a "shut-in" feeling when a closed space was presented, and a feeling of relief came when it changed to an open space. 4. Sometimes I seemed to see the frame through the side of the face, a sort of "facial vision." 5. There occasionally seemed to be a difference in temperature.

O. C.—1. I heard no sound from the moving apparatus. 2. There seemed to be a difference in temperature, and this feeling was located in the ear. 3. At times seemed to visualize. 4. Occasionally felt as if something were being pushed into my ear. 5. At times there was a feeling as if the head were being put in a box. A distinct "shut-in-ness."

F. B. D.—1. There was no sound caused by the apparatus as it moved past the face. 2. The basis for judgment seemed to be a difference in the quality of the reflected sounds. 3. When all without was very quiet, the feeling of "shut-in-ness" seemed present, and sometimes seemed localized in the temples. This localization was perhaps due to muscular tension, caused by straining the attention.[1] (This fact may in some measure account for the belief in "facial vision.") 4. Occasional differences in temperature seemed present. 5. The feeling of "shut-in-ness" arising from the nearness of the parts of the frame, is wholly different from that of direct pressure on the tympanum. 6. In later experiments, when my ears were closed with cotton, it became a difficult task to prevent my attention from wandering, because of the lack of any change in the sensation,—nothing to tie it to, as it were.

It now became necessary to devise a method of excluding the temperature and "facial vision." This was done in the following way: The ear was covered and fitted with a soft piece of cloth, in which a hole was made opposite the meatus. Then a piece of thick, soft cardboard, sufficiently large to cover the entire side of the face and neck, was cut so as to fit closely around the base of the ear to hold the cloth in place

[1] See James' Psychology, Vol. I, p. 434 f.

and shut the face from the frame. It was thought now that if the subject, after being blindfolded as before, could distinguish the separate spaces, that it would depend on differences in sound, and that the loss in discriminative ability would be due to shutting out temperature and "facial vision." The following table shows that the power of discrimination was very slightly, if at all, reduced:

Subject.	Solid and Lattice.				Solid and Wire.				Open and Lattice.			
	R.	W.	R.	W.	R.	W.	R.	W.	R.	W.	R.	W.
J. A. B.	23	0	26	0	20	0	18	0				
O. C.	23	4	21	8	24	8	22	9				
F. B. D.	92	5	90	2	52	0	51	1	21	6	23	5

It should be taken into consideration that the cloth and cardboard on the face, despite all care to prevent, caused some little distraction of the attention, and in this way would account for some loss of discriminative ability, but a comparison of this table with the foregoing one shows very little change.

In order to test the matter more thoroughly, the face was exposed as at first, but the ears were both[1] tightly stopped, and the accompanying table shows that the power to distinguish was lost entirely:

Subject.	Solid and Lattice.				Solid and Wire.				Open and Lattice.			
	R.	W.	R.	W.	R.	W.	R.	W.	R.	W.	R.	W.
J. A. B.	34	34	35	33								
O. C.	53	47	43	65								
F. B. D.	82	84	67	62	54	45	52	49	29	31	34	28

It was thought to be waste of time to complete this table of experiments with J. A. B. and O. C., for the obvious reason

[1]The fact that it was necessary to stop *both* ears tightly with cotton before the ability to discriminate was lost, suggests that this may account for Prof. James' medical friend's ability previously referred to.

that the previous experiments and those here with F. B. D. were conclusive.

The table proves beyond a doubt that with the subjects named, the basis of judgment was due to differences in sound.

The question arose whether or not these were wholly objective sounds, or partly subjective. This point was not fully determined, but the following observations were made: An acoustic telephone was fixed with the receiver near the frame, and the subject with the other end at some distance away. There was then no distinguishable difference.

Also it was noticed throughout all the experiments that too much noise in the room or outside was unfavorable to correct judgments, but this was perhaps chiefly due to distracted attention as well as to the general resonance of the room.